

Precast / Prestressed Concrete Plant Inspection – NDOR Inspector

Required Certification: ACI Field Test Technician Grade 1; NDOR Field Technician; NDOR Plant Technician; PCI Quality Control Personnel Certification Level 1 & 2

Recommended Certification: ACI Strength Test Technician Grade 1

General: Refer to Section 705 in the 1997 Standard Specification for Highways, and all Supplements to the Standard Specifications.

Each inspector is expected to perform any or all tasks within the non-administrative area of prestressed concrete inspection and control. NDOR inspectors may observe and/or verify their assigned tasks. Production tasks may continue even though an NDOR inspector is not present to observe the task, provided the production schedule has been given to the NDOR inspector and the work is proceeding according to schedule. The definition of "Verify" is that NDOR inspectors will review Plant inspectors written documentation of the task or perform separate tests. All inspectors shall obtain the required certification and should obtain the recommended certification.

Inspectors shall comply with all of the safety programs prescribed by the facility. All personnel are required to wear safety hard hats, safety footwear and safety glasses while observing and/or verifying the work in the production area.

- I. One sample of prestress strand twelve feet long from each reel shall be submitted to Materials and Research for testing 30 days before the anticipated time of use. (Sampling Guide, 705.02 paragraph 14)
- II. Inspection and recording of tensioning.
 - A. The NDOR inspector shall observe and/or verify the tensioning of all strands.
 - B. A small number of broken wires are acceptable in a setup as long as the number is limited to not more than 2%.
 1. The area of broken wires shall not exceed 2% of the cross sectional area of the stressing strand when the number of strands is 14 or less.
 2. The area of broken wire shall not exceed 1% of the cross sectional area of the stressing strands when the number of strands exceeds 14.
 3. No more than 1 broken wire will be allowed in a single strand. (705.02 paragraphs 10, 11 & 12)
- III. Checking of dimensions of members, numbers, size and positions of tendons, reinforcing steel, other incorporated materials, opening, blockouts, etc.
 - A. After the Plant inspector has notified NDOR inspector the bed is ready to be reviewed the NDOR inspector may observe and/or verify the bed.
 - B. All reinforcing steel shall be observed an/or verified to ensure the bars are of the correct type and size and have been placed in the proper location.
 - C. The type, size, anchorage and location of all embedded items shall be observed and/or verified .
 - D. The NDOR inspector should perform checks as needed to verify the quality control department data.
- IV. Regular inspection of batching, mixing, conveying, placing, compacting, finishing and curing of concrete.

- A. Portland cement concrete shall be supplied by only those plants determined by the Engineer to be in substantial compliance with the requirements in the Quality Control Manual, Section 3, Certification of Ready Mixed Concrete Production Facilities, as published by the National Ready Mixed Concrete Association. (1002.03 paragraph 2)
 - 1. The production facility shall be inspected every two years.
 - 2. Whenever there is reason to suspect a problem with the equipment, any or all of the equipment may be inspected.
 - B. The plant may choose to be certified by the National Ready Mixed Concrete Association or NDOR personnel will determine the method of inspection.
- V. Preparation of concrete specimens for strength testing and performance of concrete tests (slump, air content, unit weight, etc.).
- A. Concrete testing verification shall be the responsibility of the NDOR inspector. Table 705.03 shows the minimum required sampling and testing, the Engineer may make more correlation test samples if the quality of the plants testing is deemed inadequate.
 - B. The NDOR inspector shall observe and/or verify the sampling, fabrication and testing for all specimens.
- VI. Inspection of detensioning, product removal from beds, handling and storing operations.
- A. The NDOR inspector shall observe and/or verify the detensioning.
 - 1. Detensioning shall be accomplished before the temperatures of the units drop below 100°F and while they are still moist. (705.03,11b-9)
 - 2. If the NDOR inspector observes cracks prior to de-tensioning prestressed concrete girders the Engineer shall determine whether to repair or reject the product. (705.03,12a)
 - B. Verifying of dimensions of members, camber, numbers, opening, blockouts, etc.
 - 1. The quality control department shall notify the NDOR inspector when the product is ready to be reviewed.
 - 2. The NDOR inspector may perform checks to verify the quality control department data.
 - C. Each precast/prestressed concrete structural unit shall be stamped or marked with an identification number and its manufacture date. (705.03 paragraph 10.g)
- VII. Final inspection of finished product prior to shipment.
- A. Each piece should be marked with a number related to shop drawings and product records for accurate identification.
 - B. Visual inspection of the product for general appearance should be made. Cracking is frequently indicative of incorrect procedures in design, production, or handling.
 - C. Strand slippage should be monitored and evaluated.
 - 1. Before detensioning, mark the strand at each end of the bed with respect to the concrete at a constant distance.
 - 2. After the strands are cut the distance to the mark is measured.
 - 3. If slippage occurs, the Bridge Design Division shall be notified and the member should be evaluated.
 - D. Camber should be measured on all prestressed concrete products for which camber measurement is appropriate.
 - E. The NDOR inspector shall observe and/or verify the post-pour inspection.

- VIII. General observation of plant equipment, working conditions, weather and other items, which have the potential for affecting the products.
- IX. All products sent to state projects shall be accompanied by a shipping report. The NDOR inspector will be given the opportunity to perform a final inspection before it leaves the plant.
- X. A record keeping system for the procedures outlined above shall be utilized to establish evidence of proper manufacturing and monitoring.
- XI. Prior to leaving the plant the manufacturer shall certify that the product has been manufactured in conformance with the latest edition of the NDOR Standard Specifications for Highway Construction - Section 705 -- Precast/Prestressed Concrete Structural Units and PCI Manual for Quality Control: Structural Precast Concrete; MNL.-116.

Precast/Prestress Inspection Records and Reports

The filing pattern outlined below has been devised to ensure the integrity and uniformity of files kept in the inspector's plant file. It is expected that all such files will be kept in order and up to date.

- I. Correspondence File material shall be filed by date with current data at the front of the file and cross referenced by date of letter, date received, person receiving, also those acting upon correspondence.
 - A. State of Nebraska
 - B. Producer
 - C. Miscellaneous
- II. Materials and Tests Section
 - A. Field Gradations
 1. Fine Aggregate
 2. Coarse Aggregate
 - B. Sampling Identification material shall be filed by date/report number (Certifications are filed with report.)
 1. Fine Aggregate
 2. Coarse Aggregate
 3. Portland Cement
 4. Admixtures
 5. Prestressed Strand
 6. Concrete Reinforcing Steel
 7. Cold Rolled Steel
 8. Welded Steel Wire Fabric
 9. Neoprene Bearing Pads
 10. Miscellaneous
- III. Calibrations should be kept in this file. A copy of the latest PCI inspection report should be kept in this file. If a copy of the complete report is not in this file, the NDOR inspector shall read the report, make a copy of the deficiencies for the file and insure fixes have been made.
- IV. Product Records shall include unit status chart filled out for all units poured.
 - A. Girders
 - B. Bearing Pile by type
 - C. Sheet Pile
 - D. Architectural Sections
 - E. Miscellaneous items
- V. Check Sheets
 - A. Girder – filed by product
 1. Shipped
 2. Not Shipped
 - B. Bearing Pile – filed by length, pour number, and type
 1. Shipped

- 2. Not Shipped
 - C. Sheet Pile – filed by pour number
 - 1. Shipped
 - 2. Not Shipped
 - D. Miscellaneous Check Sheets
 - E. Reject File – carried forward year-to-year, permanent reject file carried forward for 5 years.
- VI. Steam Charts shall be reviewed or verified by NDOR inspector before girders are accepted.
- VII. Equipment Records
- A. Calibration records for NDOR testing equipment
 - B. Miscellaneous
- VIII. The NDOR inspector shall have a current copy of the plant Quality Control Plan, as it relates to state products.
- IX. Materials and Research shall be sent reports on a regular basis and shall include:
- A. Compressive Strength and Stress/Strain Data
 - 1. Project Number if known
 - 2. Unit Identification from plans
 - 3. Date Fabricated
 - 4. Proportioning Report Number
 - 5. Test Date
 - 6. Maximum Machine Load
 - 7. Compressive Strength
 - 8. Stress/ Strain Data
 - B. Shipping Report
 - 1. Project Number
 - 2. Unit Identification from plans
 - 3. Date Fabricated
 - 4. Date Shipped
 - 5. Camber at shipping for girders
 - 6. Length of each Pile

NDOR Inspector Checklist for Steam Curing

- I. Verify temperature sensor or thermometer locations.
 - A. One approved continuous recording thermometer or sensor for each 115 feet of casting bed, with a minimum of 2 thermometers or sensors located in each enclosure.
- II. Verify that steam jets are not directed at the forms.
- III. Anything that causes the forms to heat up at a faster rate than the concrete can cause problems.
 - A. Verify that the temperature of the concrete is maintained near placement temperature until the concrete has reached initial set.
 - B. Verify that the temperature rate of rise does not exceed 54°F per hour.
 - C. Verify that the temperature did not exceed 176°F.
- IV. Verify that the relative humidity inside the enclosure is maintained between 70% and 100%.
- V. Verify that the temperature in the concrete is maintained so that the difference between highest and lowest temperature station readings will not be more than 27°F.
 - A. A dial thermometer pushed through the holes in the tarp works well for checking the temperature along the unit(s).
 - B. There must be adequate room, 3 inches minimum, for the steam to circulate all the way around the forms.
 - C. Wind can blow the tarps against the forms and completely stop the steam from circulating around the units.
 - D. Make sure the end of the bed is well protected and that there is as much steam getting to the ends as the rest of the bed.
 - E. Wind blowing in the end of the bed can drastically reduce the temperature.

Precast / Prestressed Concrete Structural Unit Repairs

- I. Chipped, spalled, honeycombed, or other defects that have been determined not to affect the unit's structural integrity must be repaired or be subject to rejection. Repairs shall be made in accordance with this Policy and Section 705.03 the Standard Specifications.
 - A. All unsound concrete shall be removed.
 - B. The affected area shall be coated with epoxy resin binder meeting the requirements of Section 1018.
 - C. The formwork shall be placed and secured.
 - D. The prepared area shall be filled with class 47B-5075 concrete mix using the type of cement used in the unit.
 - E. The work shall be cured for 24 hours with wet burlap. Steam curing at 77°F will be allowed.
 - F. The patch shall be ground smooth to remove all joint seams.
- II. Surface cracking, less than ½ in deep and 1/32 inch wide, shall be sealed with an approved epoxy sealer.
- III. Cracks more than ½ in deep and 1/32 inch wide shall be evaluated by the Bridge Engineer for structural integrity before repair.
 - A. Cracks to be repaired shall be pressure grouted in accordance with accepted practice by experienced personnel.
 - B. No propagation of the cracks will be permitted during handling, storage, transporting or erecting.
 - C. Units will be inspected after loading by the plant inspector and after erecting by the field inspector to determine if the crack has propagated.
- IV. Voids less than 1 square foot of the surface and not exposing the strand that have been determined not to affect the unit's structural integrity must be repaired or subject to rejection.
 - A. All unsound concrete shall be removed.
 - B. The affected area shall be coated with epoxy resin binder meeting the requirements of Section 1018.
 - C. The formwork shall be placed and secured.
 - D. The prepared area shall be filled with an approved patching mix.
 - E. The work shall be cured for 24 hours with wet burlap. Steam curing at 77°F will be allowed.
 - F. The patch shall be ground smooth to remove all joint seams.
- V. Voids less than 1 square foot of the surface and exposing the strand may be repaired prior to release of the strand.
 - A. All unsound concrete shall be removed.
 - B. The affected area shall be coated with epoxy resin binder meeting the requirements of Section 1018.
 - C. The formwork shall be placed and secured.
 - D. The prepared area shall be filled with an approved patching mix.
 - E. The work shall be cured for 24 hours with wet burlap. Steam curing at 77°F will be allowed.
 - F. The strand shall not be released until the patch strength has reached the strength of the unit.
 - G. The patch shall be ground smooth to remove all joint seams.
 - H. The structural integrity shall be determined after the unit is moved to storage.

Elongation Instructions

Elongation shall follow the recommended practice of the Precast/Prestressed Concrete Institute except as out lined below or stated on the plans. The plant inspector shall preform elongation calculations with a report submitted to the NDOR inspector for verification.

- I. Calculate the elongations using the equation on page 36 of the PCI Quality Control Technician/Inspector Training Manual.
 - A. The Central Laboratory shall determine the Modulus of Elasticity.
 - B. Initial Tension should be from 5% to 25% of the final load, to pull the slack strand taut.
 - C. Strands are tensioned to approximately 70% of their ultimate capacity, except where the plans indicate otherwise.
 - D. Tolerance based on the PCI Quality Control Manual is $\pm 5\%$ from the desired value. This relates to the actual gage pressure and elongation verses the calculated values of each. It also relates to an algebraic comparison of the variation of the gage pressure to variations in elongations.
- II. Tensioning Corrections for elongation and load are:
 - A. Strand Seating
 - 1. Dead End Seating
 - 2. Live End Seating
 - 3. Splice Chuck Seating
 - B. Bed Shortening for self-stressing beds
 - C. Abutment Rotation of movement of anchorages for fixed abutment beds
 - D. Elongation of abutment anchor rods
 - E. Thermal Effects
 - F. Drape

Elongation Worksheet

Project: _____ **Pour Id.:** _____
Station: _____ **Date Elongated:** _____
Bed: _____ **Time Elongated:** _____

Theoretical Elongation: $E_T = (P \times L) / (A \times E)$

Where: P = Load Applied to Strand = $P_f - P_i$ A = Area of Strand
 L = Length of Strand Between Anchorages E = Modulus of Elasticity of Strand

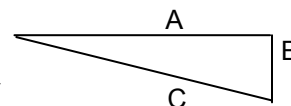
The Physical Tests Laboratory shall determine the modulus of elasticity and area of strand.

Load Corrections

If draped strand are used, the applied load shall be corrected because the draping process will add load.

Change in elongation for draping $E_d = C - A$

$C = \sqrt{A^2 + B^2}$



A correction for temperature will be made if the temperature increases 25°F or more from the time of stressing to the time of initial set.

Δ Elongation $E_t = 0.0000065 \times T_{\Delta} \times L \times 12$ Corrected Load $P_t = (1 + E_{\Delta} / E_T) \times P \leq \% \text{ Ultimate Strength}$

Corrected Elongation $E_c = E_T + E_t - E_d$ Target Load $P_T = (E_C \times A \times E) / L$

Elongation Corrections

Strand Seating = S = Dead End + Live End + Splice Chuck

Bed Shortening = B

Abutment Rotation, or Anchorage Movement = R

Elongation of Abutment Anchor Rods = A

Final Theoretical Elongation: $E_f = E_c + S + B + R + A$

Strand Load / Elongation Table

Strand	Load			Elongation		
Location	High	Actual	Low	High	Actual	Low

Computed By: _____ (*Plant Inspector*)

Verified By: _____ (*NDOR Inspector*)

